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Title: Does father-child conflict mediate the association between fathers' postnatal depressive symptoms and children's adjustment problems at 7 years old?

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Background: Paternal depressive symptoms are associated with children's emotional and behavioural problems, which may be mediated by negative parenting. But there is no research on the influence of paternal depressive symptoms on children's emotion regulation and limited literature investigating fathers' parenting as a mediator in the pathway between paternal depressive symptoms and children's externalising and internalising problems. We aimed to investigate the mediating role of father-child conflict (at 3 years) in the association between postnatal paternal depressive symptoms (at 9-months) and children's emotional and behavioural (at 7 years) (aim 1). We also examined whether mediation pathways were more pronounced for boys or for girls (aim 2).

Methods: Secondary data analysis was conducted on the Millennium Cohort Study, when children were 9-months, 3-years and 7-years-old (n=3,520). Main study variables were measured by self-report questionnaires. Fathers completed the Rutter Scale (depressive symptoms) and the parent-child relationship questionnaire (father-child conflict), while mothers completed the Strengths and Difficulties questionnaire and the Social behaviour questionnaire (child emotional and behavioural problems, emotion regulation). We used structural equation modelling to estimate direct, indirect and total effects of paternal depressive symptoms on child outcomes, mediated by father-child conflict whilst adjusting for relevant covariates (maternal depressive symptoms, child temperament, marital conflict, and socio-economic factors such as poverty indicator and fathers' education level). Multi-group and interaction analysis was then conducted to determine the differential effect by gender of the association between paternal depressive symptoms on child outcomes via father-child conflict.

Results: Father-child conflict mediated the association between paternal depressive symptoms and emotion regulation problems (SIE – CI: -0.03 - -0.01, $p<0.001$; STE–CI: -0.03 - -0.01, $p<0.05$) (aim 1). Father-child conflict mediated a larger proportion of the effect in boys (SIE CI: -0.03- -0.01, $p<0.001$, STE–CI: -0.05- -0.00, $p=0.063$) than it did in girls (SIE–CI: -0.02- -0.01, $p<0.001$, STE–CI: -0.04 - 0.01, $p=0.216$) (aim 2).

Conclusions: Father-child conflict may mediate the association between postnatal paternal depressive symptoms and children's emotion regulation problems. Paternal depressive symptoms and father-child conflict resolution may be potential targets in preventative interventions.

Key words: Paternal depressive symptoms, parenting, father-child conflict, behavioural problems, emotion regulation.

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Introduction

Postnatal depressive symptoms in fathers are associated with behavioural and emotional problems in children (Davé *et al.*, 2008, Fletcher *et al.*, 2011, Ramchandani *et al.*, 2005, Ramchandani *et al.*, 2008b), but there is limited understanding about the underlying mechanisms that explain these associations. Childhood behavioural and emotional problems are associated with poor outcomes during adulthood, including academic underachievement, psychiatric problems, relationship difficulties, substance abuse and dependency on services (Caspi *et al.*, 1996, Fergusson *et al.*, 2005). This causes considerable burden on public services and has huge costs on society (Scott *et al.*, 2001, Snell *et al.*, 2013). Improved understanding of how paternal depressive symptoms influence children's behavioural and emotional outcomes during childhood may improve theoretical understanding about the transmission of risk from parents to children and might provide targets for interventions involving fathers (Garfield, 2015, Ramchandani and Murphy, 2013).

Using longitudinal data form the Millennium Cohort Study (MCS), Malmberg and Flouri (2011) found that paternal depressive symptoms at 9 months old predicted behavioural problems in children when they were 3 years old via lower overall quality (lower warmth and higher conflict) in father-child relationship. Using another large cohort study (Longitudinal Study of Australian Children: LSAC study), Giallo *et al.* (2014b) reported that paternal depressive symptoms during infancy were associated with children's emotional and behavioural problems at 4-5 years old, and the association was mediated via increased hostile parenting. Child gender did not appear to moderate this association. In both studies, fathers' parenting and children's outcomes were measured at the same time-point, therefore causality cannot be assumed. Finally, a study of fathers with children aged 5-9 years old found inconsistent discipline practices mediated the association between paternal depressive symptoms and their sons' hyperactivity, but not their daughters' (Dette-Hagenmeyer and Reichle, 2014). Although there was a longitudinal element to this study, paternal depressive symptoms and parenting were measured simultaneously and the measure of child outcomes was collected 6-months later, making the analysis almost cross-sectional.

Evidence suggests that poor emotion regulation in children may be associated with increased externalising and internalising behavioural problems (Eisenberg *et al.*, 2010). Difficulty with regulating anger and impulsivity (under-regulation) has been linked with externalising problems, whereas inability to control cognition and attention (over-regulation involved in rumination and negative bias) have been associated with internalising

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problems (Gross, 1998). Studies have also focused on the effects of maternal depression on children's emotion regulation, and have reported that children of depressed mothers have poorer emotion regulation compared to children of non-depressed mothers (Silk *et al.*, 2006). This may be due to the environmental influence of depressed mothers' inability to parent sensitively or children modelling mothers' maladaptive emotion regulation strategies (Eisenberg *et al.*, 2001, Hoffman *et al.*, 2006). Although there have been studies on the importance of fathers to the development of emotion regulation among children (Cabrera *et al.*, 2007, Kiel and Kalomiris, 2015, Wilson *et al.*, 2014), to our knowledge there are no studies that examine the association between paternal depressive symptoms and children's emotion regulation.

There are some studies that provide evidence for the potential mechanisms by which paternal depressive symptoms may influence children's emotional and behavioural problems. One hypothesis proposes that paternal depressive symptoms may influence children's development via fathers' impaired parenting (Ramchandani and Psychogiou, 2009). Depression in parents has been associated with negative parent-child interactions (Psychogiou and Parry, 2014, Sethna *et al.*, 2015) and a meta-analysis of 28 studies reported paternal depressive symptoms to be associated with increased negative (intrusive, hostile, harsh, controlling, and critical) and decreased positive parenting behaviours (sensitive responding, accepting, warm, affectionate, and supporting) towards children (Wilson and Durbin, 2010). One study found that fathers' disengaged parenting when their infants were 3-months old predicted externalising problems at 1 year in their sons, but not daughters (Ramchandani *et al.*, 2013). Another meta-analysis consisting of 6 studies reported that father-child conflict mediated the association between paternal depressive symptoms and children's emotional problems (Kane and Garber, 2004). However, the studies in this meta-analysis included children with a wide age range (from 3 to 14 years) and most studies were cross-sectional. To infer mediation, it is necessary to study the exposure of paternal depressive symptoms, fathers' parenting and children's outcomes longitudinally (Selig and Preacher, 2009). Thus, the variables need to be measured at different time-points. Additionally, given that there were only 6 studies on father-child conflict, mediation requires further investigation.

Although studies have found a link between paternal depressive symptoms and children's behavioural and emotional problems (Davé *et al.*, 2008, Ramchandani *et al.*, 2005, Ramchandani *et al.*, 2008b), there are mixed findings about the influence of paternal depressive symptoms regarding child gender-specific pathways of risk transmission. Postnatal depressive symptoms in fathers 8 weeks after child birth were associated with children's

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psychopathology at 3 and 7 years old in the UK Avon Longitudinal Study of Parents and Children (ALSPAC) (Ramchandani *et al.*, 2005, Ramchandani *et al.*, 2008b); sons of fathers with high depressive symptoms were reported to display more conduct problems compared to daughters. In contrast, findings from the LSAC suggested that the daughters of fathers with high depressive symptoms in the first post-natal year were more likely to have emotional and conduct problems when they were 4-5 years old, whereas sons were more likely to exhibit hyperactivity problems and lower levels of prosocial behaviour (Fletcher *et al.*, 2011). Exploring gender-specific pathways may help explain the possible father to child transmission of risk which may subsequently enable us to identify whether girls and/or boys are more vulnerable to their fathers' depressive symptoms. This could influence the content and direction of interventions with depressed fathers.

[Insert Figure 1 here]

This study aims to address these gaps in the current literature using a large representative sample of fathers from the MCS in the UK. The primary objective is to test the proposed model (Figure 1) and investigate whether father-child conflict mediates the association between paternal depressive symptoms and children's emotional and behavioural outcomes. The exposure of paternal depressive symptoms during infancy has been identified as a potential sensitive period where paternal depressive symptoms may influence children's later outcomes (Ramchandani *et al.*, 2008a). The mediator variable father-child conflict was measured at 3 years old during the preschool year when fathers' become more involved in parenting their children (Bruce and Fox, 1999, Grossmann *et al.*, 2002, MacDonald and Parke, 1986). Previous literature has associated father-child conflict with paternal depression and negative outcomes in children (Kane and Garber, 2004, 2009) . Additionally, using the MCS dataset, a recent study found an association between paternal depressive symptoms and father-child conflict, but not father-child warmth or fathers' involvement in parenting activities, suggesting that father-child conflict may be an important construct that is influenced by paternal depressive symptoms (Nath *et al.*, 2015). Children's outcomes were measured at 7 years old. This is a developmentally challenging period as children learn new behaviour and emotion management skills and problems with adjustment at this age predict poor outcomes in adulthood (Fergusson *et al.*, 2005, Pianta *et al.*, 1995). Given that maternal depression, marital conflict, child temperament, child gender, and family socio-economic status may be associated with fathers' depressive symptoms, parenting and children's emotional and behavioural outcomes (Flouri *et al.*, 2014,

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Goodman, 2004, Gutierrez-Galve *et al.*, 2015, Hanington *et al.*, 2012, Hanington *et al.*, 2010, Kiernan and Huerta, 2008, Malmberg and Flouri, 2011), we controlled for these factors in our models. Our secondary objective was to test the moderating influence of child gender on any potential associations. We predicted that higher father-child conflict at 3 years old would mediate the association between higher paternal depressive symptoms at 9-months old and children's increased behavioural-emotional outcomes at 7 years. We expected that child gender would moderate this mediation, but did not expect a specific direction given the mixed literature.

Methods

Participants

This secondary data analysis was conducted using the first (S1), second (S2) and forth (S4) sweeps of the Millennium Cohort Study (MCS), when children were 9 months, 3 years and 7 years old. The MCS is a large-scale survey of infants (n=19,519) born in four constituent countries of the United Kingdom (Dex and Joshi, 2005). The sample design allowed for over-representation of families living in areas with high rates of child poverty or high proportions of ethnic minorities in England and the three smaller countries in the UK (Northern Ireland, Wales, and Scotland). Full details of the survey, objectives, content of survey and sampling strategy can be found in the documentation attached to the data deposited with the UK Data Archive and elsewhere (Hansen, 2014, Plewis and Ketende, 2006). MCS had informed consent from participants and ethical approval (Hansen, 2012). Our work was a secondary analysis of anonymised data that is publically available on the website (http://discover.ukdataservice.ac.uk/series/) requiring no direct contact with the individual participants, so further ethical approval was not required.

The first wave (S1) of data was collected from 2001-2002 on 18,533 families, with a total of 18,819 infants aged between 9-11 months. The same sample were then invited to follow-up with 15,590 families in the second wave (S2) when the children were approximately 3 years old and 13,857 in the fourth wave (S4) when children were approximately 7 years old.

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178 The MCS collected data from main respondents (usually mothers) and partner respondents (fathers, step fathers,
179 same sex partners). For the current study, the sample was limited to biological fathers (partner respondents) and
180 mothers (main respondents). Fathers who were main respondents were excluded to simplify analysis as main
181 and partner questions were not identical. Part-time resident and step-fathers were also excluded due to
182 insufficient numbers. A small sample of twins and triplets were excluded to avoid the need to include an extra
183 level of analysis that would have accounted for intra-family variability. Thus, only one child per family (the first
184 cohort member) was studied. See Figure 2 for details of eligibility, sample size at each stage and final sample
185 used for main analysis.
186
187 [Insert Figure 2 here]
188
189 *Measures*
190 Paternal depressive symptoms
191 Rutter's 9-item Malaise Inventory (S1 – 9 months old) was used as an indicator for depressive symptoms in S1
192 completed by fathers (Dex and Joshi, 2004, Rutter *et al.*, 1970). This is the shortened version of the Rutter's 24-
193 item Malaise Inventory self-completion questionnaire measuring psychological distress (Bartley *et al.*, 2004,
194 Johnson, 2012, Rutter *et al.*, 1970). The 9-item short form included items "feel tired most of the time", "feel
195 miserable or depressed", "worried about things", "often get into a violent rang", "suddenly become scared for no
196 good reason", "easily upset or irritated", "constantly keyed up and jittery", "every little thing gets on nerves and
197 wears you out", and "heart race like mad". Scores from these were summed to create a continuous scale. This
198 scale has been used in previous studies as an indicator of depressive symptoms (Kiernan and Huerta, 2008,
199 Malmberg and Flouri, 2011). Using Cronbach's alpha (α) coefficient the internal consistency of the scale was
200 0.75 for mothers and 0.71 for fathers which is similar to previous validation studies on the scale (Rodgers *et al.*,
201 1999). The original scale has also shown acceptable validity (Area Under the Curve (AUC) = 0.74 with mental
202 health problems , AUC = 0.77 with psychiatric diagnosis, AUC = 0.87 with depression) (Rodgers *et al.*, 1999).
203
204 Fathers' parenting: Father-child conflict
205 Fathers' parenting was measured using The Child-Parent Relationship Scale reported by fathers (CPRS; Short
206 form, (Johnson, 2012, Pianta and Steinberg, 1992). In this study, father-child conflict refers to the
207 communication and relationship between the parent and the child which is measured by 8 self-report items on a

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5-point Likert scale (ranging from 1=definitely does not apply to 5= definitely applies). All items were summed to create a continuous scale. Items include "child and I always seem to be struggling with each other", "child uncomfortable with physical affection or touch by me", "child easily becomes angry with me", "child remains angry/resistant after discipline", "dealing with my child drains my energy", "when child wakes up in bad mood, I know we're in for a long and difficult day", "child's feelings towards me can be unpredictable or change suddenly" and "child is sneaky or manipulative with me". This scale has been used by other studies as an indicator of parenting (Kiernan and Huerta, 2008, Mensah and Kiernan, 2011, Nath *et al.*, 2015) and the items originate from attachment theory, Attachment Q-set and literature on parent-child relationships to form a subscale looking at negative approach towards father-child relationship (conflict). Higher scores on the scale indicated higher conflict in relationship. Fathers' reports are comparable to mothers' reports and have been validated against observational data on parent-child interactions which has shown conflict ratings on the CPRS to correlate with observational coding of hostility (Driscoll and Pianta, 2011). The scale had adequate internal consistency (α=0.73).

Child behavioural and emotional problem

The Strengths and Difficulties Questionnaire (SDQ; (Goodman, 2001)) completed by mothers was used to assess child emotional and behavioural problems (S4, 7 years old). The SDQ is validated for children aged 3-16 years old and was developed as a clinical tool to identify psychopathology. There are 25 items in total consisting of five continuous subscales: emotional symptoms, conduct problems, hyperactivity, peer problems and prosocial behaviour. The scores for each subscale range between 0-10. All sub-scales were used in the analysis. Higher scores indicate greater problems on the emotional, conduct, hyperactivity, and peer problems, whereas higher scores on the prosocial scale indicated more prosocial behaviour. The internal consistencies from the MCS were: conduct problems α= 0.55, emotional problems α=0.68, hyperactivity α= 0.78, peer problems α=0.59 and prosocial α=0.71. These are similar to internal consistencies reported in other studies using non-clinical samples of children (Muris *et al.*, 2003, Niclasen *et al.*, 2012). The scale has also been reported to have sufficient validity against diagnostics of DSM-IV disorders (specificity=96%, sensitivity=49%) (Goodman, 2001) and Child Behaviour Chick List (CBCL; r=0.76) (Stone *et al.*, 2010).

Child emotion regulation

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The MCS team selected items from the Child Social Behaviour Questionnaire (CSBQ) (Hogan *et al.*, 1992, Johnson, 2012) that were completed by mothers and used to generate three continuous sub-scales; 1) self-regulation defined as children's ability to adapt to situations independently, 2) emotion dysregulation defined as children's inability to deal with difficult/frustrating situations, and 3) cooperation defined as children's ability to cooperate with others. The self-regulation and the reverse of emotion dysregulation scales were significantly correlated ($r=0.32$, $p<0.001$) and were summed to create an emotion regulation scale for the analysis. The cooperation subscale was not used because it does not belong to the emotion regulation construct. Higher scores on the emotion regulation scale indicated more adaptive emotion regulation. The internal consistency of the scale was $\alpha= 0.72$. This scale devised by the MCS team has been used in other studies to measure emotion regulation (Flouri *et al.*, 2014).

Family context covariates

Maternal depressive symptoms (S1- 9 month) were measured using the Rutter Malaise Inventory as above (Dex and Joshi, 2004, Johnson, 2012, Rutter *et al.*, 1970). Children's temperament (S1- 9 months) was measured with mothers' reports on the Carey Infant Temperament Scale (Carey and McDevitt, 1978). Fourteen items from the original scale were selected by the MCS team to measure regularity (4 items), approach withdrawal (3 items), adaptability (2 items) and mood (5 items), and has also been used in other studies as an indicator of child temperament (Flouri and Malmberg, 2012, Kiernan and Huerta, 2008). Items were on a 5-point scale (almost never, rarely, usually does not, often, almost always). All scores were on a continuous scale ranging from (14 – 70) consisting of the total score of all items. Higher scores indicated easier infant temperament and lower scores indicated more difficult temperament. The internal consistency of the scale was $\alpha=0.66$. Marital conflict (S1- 9 months) was measured using the modified version of the Golombok Rust Inventory of Relationship State (Rust *et al.*, 1990). The original 28-item questionnaire had high content validity and reliability of Cronbach's alpha = 0.91 (men) and 0.87 (women). The MCS selected seven items at S1 and S2, and three items at S4 (Johnson, 2012). These were summed to create continuous scales where higher scores indicate higher levels of relationship conflict.

Socioeconomic Status (SES)

Households were classed as living in poverty if their income was equal to or less than 60% of the median household income for the UK (dichotomous scale), the definition of poverty set by the UK government

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(Ketende and Joshi, 2008). Paternal education was reported by fathers and was categorised into two groups: no qualification or school level, degree and higher degree (NVQ level or equivalent, undergraduate and post-graduate degree).

Statistical analysis

Structural Equation Modelling (SEM) using Stata for Windows version 13 was used to test the mediation model illustrated in Figure 1, i.e., whether 'father-child conflict' (3 years) mediated the association between 'paternal depressive symptoms' (9 months) and 'child outcomes' at 7 years old (conduct problems, emotional problems, hyperactivity, peer problems, prosocial and emotion regulation). The model estimated standardised direct, indirect and total effects, as well as adjusting for a number of relevant covariates (maternal depressive symptoms, marital conflict, child temperament, child gender and SES) (model 1). Outcomes that were significantly associated with paternal depressive symptoms in model 1 were taken forward into a multi-group SEM analysis. This investigated whether child gender moderated the associations between 'paternal depressive symptoms' and 'child outcomes' mediated by 'father-child conflict' while controlling for maternal depressive, symptoms, marital conflict, child temperament and SES (model 2). The SEM mediation model was run again using interaction terms to further investigate whether gender interacted with the exposure or mediator to influence the outcome child variables while controlling for maternal depressive symptoms, marital conflict, child temperament and SES (model 3). Finally, we further controlled for marital conflict in subsequent sweeps to increase the validity of any associations found in model 3 (model 4).

As the sample was stratified, sampling weights were used in all analyses to adjust for the disproportionate number of participants from ethnic minority and low socio-economic status backgrounds initially recruited into the sample at S1. Weights aimed to return the sample to the structure of the UK population and also to account for the effect of attrition and multi-stage cluster sampling strategy used by the MCS. The use of the weights is recommended by the MCS team and available with the dataset. Missing data were not analysed. Only data with complete cases on variables of interest across time-points were included in the analysis. In order to check that the results in the 'complete cases' model were robust to the effects of attrition, missing data were imputed from all variables included in the analysis. A sensitively analysis was conducted to check that results were broadly replicated when missing data were imputed.

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Results

Descriptive statistics

Table 1 shows descriptive statistics for the study main measures (exposure, mediator and outcomes). Logistic regression analyses were used to test for gender differences. Compared to boys, girls had lower odds of conflict with their fathers (OR: 0.99, 95% CI: 0.98-0.98, p=0.011), conduct problems (OR: 0.84, 95% CI: 0.80-0.87, p=<0.001), hyperactivity (OR: 0.85, 95% CI: 0.83-0.88, p=<0.001), and peer problems (OR: 0.92, 95% CI: 0.89-0.96, p=<0.001), but higher odds of prosocial problems (OR: 1.25, 95% CI: 1.21-1.30, p=<0.001) and adaptive emotion regulation (OR: 1.54, 95% CI: 1.41-1.68, p=<0.001). There was no significant associations between child gender and fathers depressive symptoms (OR: 0.98, 95% CI: 0.95-1.01, p=1.135) or child emotional problems (OR: 1.03, 95% CI: 0.99-1.07, p=0.100).

The predictor (paternal depressive symptoms), mediator (father-child conflict) and outcomes (child emotional and behavioural problems) were significantly correlated, a necessary requirement for mediation to occur (Table 2).

[Insert Table 1 here]

[Insert Table 2 here]

Attrition and missingness

Attrition (i.e. fathers who did not take part in Sweeps 2 (3 years) and 4 (7 years)), and missingness (i.e fathers who did not provide complete answers to survey questions) were associated with low socio-demographic factors (Table 3). Fathers had a higher odds of dropping out by both follow-up sweeps if they were below the 60% median of the poverty indicator (S2 –OR: 3.14, 95% CI: 2.63-3.74, p=<0.001; S4 - OR: 2.31, 95% CI:1.96-2.72, p=<0.001) and had lower odds if they were educated (S2 –OR: 0.45 , 95% CI: 0.35–0.50, p=<0.001; S4 - OR: 0.63, 95% CI:0.53-0.75, p=<0.001). Fathers with higher depressive symptoms also had higher odds of dropping out (S2 –OR: 1.08, 95% CI: 1.06-1.11, p=<0.001; S4 - OR: 1.07, 95% CI: 1.04-1.10, p=<0.001).

[Insert Table 3 here]

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Covariates

All family and socio-economic covariates that were associated with higher paternal depressive symptoms, father-child conflict and child outcome, and therefore were controlled for in the analysis models (See online supplementary tables 1 and 2).

Mediation model

Table 4 (Model 1) shows that after adjusting for relevant covariates (maternal depressive symptoms, child temperament, marital conflict, child gender and family SES), higher father-child conflict mediated the association between high paternal depressive symptoms at 9-months and children's increased conduct problems, and emotion dysregulation at age 7 years old. The estimated total effects of paternal depressive symptoms on children's emotional, hyperactivity, prosocial behaviour and peer problems were not significant and therefore were not taken forward into model 2. Table 4 shows the coefficients for each outcome (Model 1).

[Insert Table 4 here]

Moderation by gender

Model 2 tested for child gender moderator effects (Table 4). This model included significant outcomes from model 1 (conduct problems and emotion regulation) and also adjusted for maternal depressive symptoms, marital conflict, child temperament and SES. Higher father-child conflict mediated the association between higher paternal depressive symptoms and boys increased conduct problems (Table 4, Model 2). This association was also marginally significant for emotion regulation. No significant effects were found for girls, which suggest that paternal depressive symptoms may have an effect via conflict on conduct and emotion regulation problems in their sons but not in their daughters.

After testing for interaction effects (Model 3), high father-child conflict still significantly mediated the association between higher post-natal paternal depressive symptoms and boys' conduct problems and emotion regulation. Table 4 (Model 3) shows the standardised coefficients for each outcome according to gender interaction with the exposure paternal depressive symptoms and mediator father-child conflict. For conduct problems, child gender interacted with both paternal depressive symptoms and father-child conflict while for

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emotion regulation, child gender interacted significantly with father-child conflict. After further adjusting the model for marital conflict at all time-points (table 5, model 4), higher father-child conflict still significantly mediated the association between high post-natal paternal depressive symptoms and emotion regulation, but the association between paternal depressive symptoms and child conduct problems became non-significant. In this model, child gender interacted significantly with father-child conflict, but not paternal depressive symptoms in the association between paternal depressive symptoms and child emotion regulation. The model fit statistics show that model 4 is the best fit. The final overall model (model 4) explained 59% of the variance (R^2=0.59).

Sensitivity analysis

The sensitivity analysis using imputed data replicated the findings in the main analysis in that all effects remained significant. In fact, significant findings increased in the main analysis model 1 (see online supplementary table 3). Therefore, this suggests that we have underestimated the effects of paternal depressive symptoms on children's emotional and behavioural problems via father-child conflict; therefore further analysis was not undertaken using the imputed datasets on models 2, 3 and 4.

Discussion

As hypothesised, higher paternal depressive symptoms at 9 months were significantly associated with children's emotion regulation at 7 years old, via higher father-child conflict when children were 3 years old. Thus, depressive symptoms in fathers may influence their mood. Therefore these fathers may struggle with conflict resolution with their toddlers and this negative interaction may later impact on their children's emotional development during early school years. These findings extend previous studies investigating the association between paternal depressive symptoms, fathers' parenting and children's emotional and behavioural problems (Dette-Hagenmeyer and Reichle, 2014, Giallo *et al.*, 2014b, Kane and Garber, 2009, Malmberg and Flouri, 2011, Ramchandani *et al.*, 2005, Ramchandani *et al.*, 2008b) and add to literature by using longitudinal data from key time points. This study is also the first to our knowledge that has investigated the association between paternal depressive symptoms and children's emotion regulation. Our findings also extend the literature by adding that father-child conflict may mediate this association path. Furthermore, we found that gender had an interaction effect with father-child conflict and not fathers' depressive symptoms. These findings suggest that father-child conflict may be an important factor that could be targeted to reduce emotional and behavioural

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problems in sons of fathers suffering from depression. Our findings that boys with poorer emotion regulation abilities had higher externalising problems is also in line with previous research (Eisenberg *et al.*, 2010).

Parental socialisation provides an environmental explanation for our findings (Eisenberg *et al.*, 2001). Previous studies have shown that maternal depression negatively impacts on their daughters' emotion regulation abilities but not sons' (Silk *et al.*, 2006). As emotion regulation abilities are learnt from socialisation with parents during early development, these results may indicate that same-gendered parents have a greater influence on their children in this process (Eisenberg *et al.*, 2001). Compared to mothers, fathers have been reported to respond more harshly and provide less support towards their son's emotional expressions, which according to role model theory may subsequently be imitated by boys (Brody and Hall, 2008, Brown *et al.*, 2015, Chaplin *et al.*, 2005, Fischer, 2000, Sanders *et al.*, 2015). This may cause conflict interactions between fathers and their sons, which may lead to emotional and behavioural problems (Kane and Garber, 2004, 2009). An alternative explanation is that our findings could be due to genetic heritability or an interplay between gene-environment (Natsuaki *et al.*, 2014, Ramchandani and Psychogiou, 2009). Sons of depressed fathers could be genetically predisposed to developing depressive symptoms and also exposed to the family environmental factors associated with paternal depressive symptoms (Gutierrez-Galve *et al.*, 2015, Rutter, 2009, Rutter *et al.*, 1997), which may increase father-child conflict and child emotional problems. However, more research is needed to support both of these explanations. As the current study could not control for genetic influences, this is something that could be addressed by future research.

We also found that higher paternal depressive symptoms at 9 months were significantly associated with children's conduct problems at 7 years old, via higher father-child conflict when children were 3 years old after controlling for maternal depressive symptoms, child temperament, and family SES which was in line with previous literature (Ramchandani *et al.*, 2005, Ramchandani *et al.*, 2013, Ramchandani *et al.*, 2008b). However, after further controlling for marital conflict at all time-points, the overall associations between paternal depressive symptoms and child conduct problems became non-significant. One explanation for this could be that marital conflict may have a stronger influence on children's behavioural problems (Braithwaite *et al.*, 2015, Hanington *et al.*, 2012) compared to paternal depressive symptoms (predictor variable). Additionally, marital conflict and father-child conflict (mediator variable) are closely related variables that may jointly be influencing the association between paternal depressive symptoms and child outcomes within the model (Cummings and

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Miller-Graff, 2015, Margolin *et al.*, 2001). Therefore, future studies should aim to differentiate and disentangle the effects of different conflictual relationships within the family in relation to child adjustment, perhaps with observational rather than self-report measures.

The current study has a number of strengths. First, the MCS is a unique dataset with a large representative sample of UK fathers (Hansen, 2014, Plewis and Ketende, 2006). Second, the MCS collected a large number of measures on mothers, fathers and children, most of which were well validated and reliable and we tested children's outcomes longitudinally (Johnson, 2012). Third, our findings are further strengthened by child outcomes being reported from mothers, decreasing any variances produced by same informant reporter bias of predictors and outcomes. Finally, the MCS (like other cohort datasets) is subjected to attrition and missing data. However, research indicates that even when dropouts are taken into account, regression models with large cohort studies are still robust (Wolke *et al.*, 2009). In addition, our analysis accounted for attrition/missing data by utilising sampling weights recommended by the MCS team (Ketende and Jones, 2011). This increased the representativeness and accounted for missing data/attrition rates that might have influenced or biased the results. We further conducted a sensitivity analysis using multiple imputation, a statistical method used in recent years to account for attrition in cohort studies (Niarchou *et al.*, 2015, Sterne *et al.*, 2009). This replicated our main finding, and if anything suggests that we have underestimated the effects.

There were also some limitations. Firstly, we lacked data on clinical diagnoses of depressive episodes using interview methods, which some might argue would be more informative. Parenting was also measured using self-reports, which might not be accurate due to biased reporting of positive parenting and inter-association with fathers reporting high depressive symptoms and higher conflict parenting. Parenting is often measured using observational methods of parent-child interactions (Aspland and Gardner, 2003). However, in both cases conducting studies using observational and interview methods with such a large sample size would be expensive, time-consuming, and impractical. Thus, the study of the influence of depressive symptoms is useful as results can later be tested experimentally using smaller clinical samples. Secondly, the coefficient effect sizes of the associations were small. Previous studies investigating mediation effects using large cohort studies have also reported small effect sizes of maternal and paternal depressive symptoms on child outcomes (Giallo *et al.*, 2014a, Giallo *et al.*, 2014b, Malmberg and Flouri, 2011). Given that the MCS consisted of a normal population of fathers, clinically relevant high levels of depressive symptoms would have been underestimated due to the

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likelihood of depressed fathers being less motivated to participate and therefore might have resulted in small effect sizes. A smaller scale study consisting of a clinical sample of depressed fathers may yield larger effect sizes. This is something for future studies to investigate. However, given the huge challenges with recruiting depressed fathers to participate in research with their children (Garber *et al.*, 2011, Pilowsky *et al.*, 2014, Sherr *et al.*, 2006), the findings from large cohort studies such as the MCS offers useful insight into the possible associations in this field of limited literature (Fagan, 2014, Niarchou *et al.*, 2015). These findings, if replicated with a clinical population, could suggest targets for development of clinical interventions.

We also assumed causal direction due to the data originating at different time points across the child's life. We are assuming linear relationships when in fact the interrelationships between parental mental health, parenting and children's development is likely to be complex and these factors may amplify and feedback on each other. Therefore, our findings need to be replicated experimentally to draw firm conclusion about causal direction. This could only be done in by using treatment trials for paternal depression which provide an opportunity to see if father-child conflict and child emotional/behavioural problems are reduced among fathers who respond compared to those who do not respond to treatment.

Finally, we acknowledge that there are more statistically advance techniques for testing mediation using Cross-Lagged Panel Modelling (CLPM) and Latent Growth Mediation (LGM) Modelling (Selig and Preacher, 2009). These techniques account for autoregressive controls, reverse causality and trends (slopes and intercepts) between associations (Cole and Maxwell, 2003, Maxwell and Cole, 2007, Maxwell *et al.*, 2011). These methods have been used to investigate moderation and mediation in maternal depression, mothers' parenting and children's behavioural outcomes (Beauchaine *et al.*, 2005, Belsky *et al.*, 2007, Eisenberg *et al.*, 2005). However, these statistical techniques require all variables to be available at all time-points (Selig and Preacher, 2009), which was not the case in the MCS, restricting the analysis method we could utilise. Specifically with regards to our research question, it would be important to investigate family context factors that may change over time such as maternal and paternal depressive symptoms. Thus, future research work could expand the statistical analysis of this paper by using longitudinal multivariate analysis with more statistically advanced techniques to build on the findings of this paper once appropriate samples are available.

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Despite some of the limitations, the findings of this study add to theoretical understanding of indirect effects of fathers' postnatal depressive symptoms to their children's outcomes. Postnatal paternal depressive symptoms were associated with boys' emotion regulation problems at 7 years old via higher father-child conflict at 3 years old. This association still remained significant after accounting for maternal depressive symptoms, child temperament, SES and marital conflict (at all time points). There are some specific implications that can be taken from the current study to inform parenting interventions. For example, parenting interventions could help with managing conflict parent-child relationships between depressed parents and their children. This may have potential to break the intergenerational transmission of risk. Parenting interventions involving fathers have been found to lessen behavioural problems in children mainly due to the change in fathers' parenting (Wilson *et al.*, 2014), therefore involving depressed fathers in such interventions maybe beneficial. Like maternal depression, studies have shown paternal depression to have a cost on public health care services (Edoka *et al.*, 2011), but intervention programs are still primarily targeted at mothers (Panter-Brick *et al.*, 2014). In light of our findings we would encourage more research with fathers and involvement of fathers in parenting programs of depressed parents.

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Required statements

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Ethical standards: The authors assert that all procedures contributing to this work comply with ethical standards of the relevant national and institutional committees on human experimentation. More specifically, the Millennium Cohort Study had informed consent from participants and ethical approval. Our work was a secondary analysis of anonymised data that is publically available on the website (http://discover.ukdataservice.ac.uk/series/) requiring no direct contact with the individual participants, so further ethical approval was not required.

Contribution of each author statement:

Dr Selina Nath: Conception and design, data analysis, interpretation of data, write-up of article, revising it critically for important intellectual content and final approval of the version to be published.

Dr Ginny Russell: Conception and design, provided guidance with data analysis, interpretation of data and analysis, revising it critically for important intellectual content and final approval of the version to be published.

Prof Willem Kuyken: Interpretation of data and analysis, revising it critically for important intellectual content and final approval of the version to be published.

Dr Lamprini Psychogiou: Conception and design, interpretation of data and analysis, revising it critically for important intellectual content and final approval of the version to be published.

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Figures

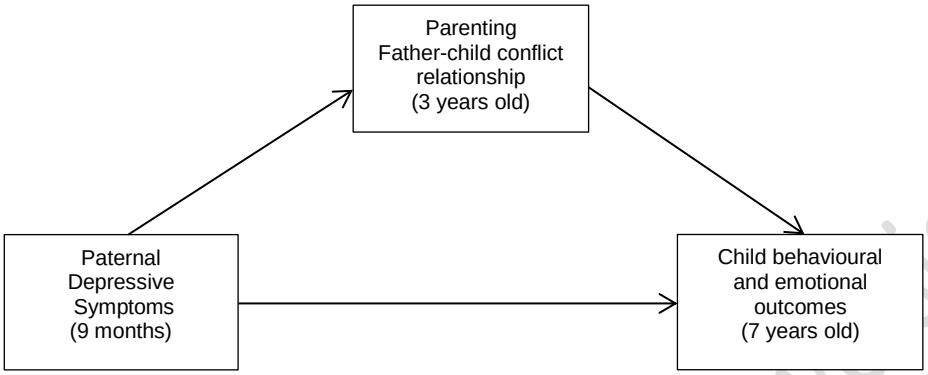

Figure 1 Proposed mediation modelling showing the effect of paternal depressive symptoms on child behavioural and emotional outcomes

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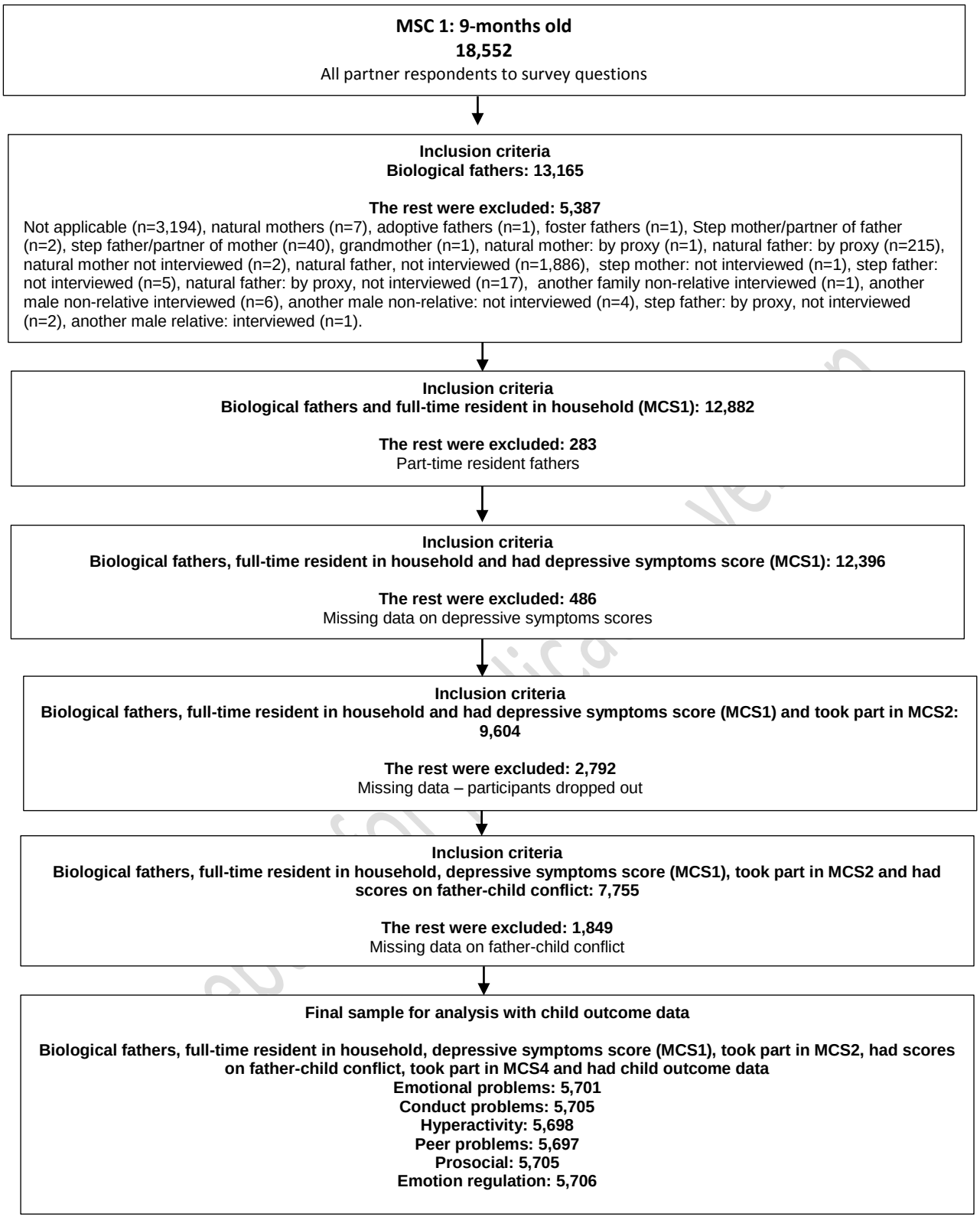

Figure 2: Eligibility flow chart for fathers in the sample

Tables

Table 1 Sample size, means and standard deviations of predictor, mediator and outcome variables for all children, boys and girls

Variables	All children N	All children mean (SD)	Boys N	Boys mean (SD)	Girls N	Girls mean (SD)
Predictor variable						
Paternal depressive symptoms(S1 9 months)[a]	12,396	1.35(1.53)	6360	1.37(1.52)	6036	1.32(1.54)
Mediator variable						
Father-child conflict(S2 – 3 years)[a]	7,755	18.03(5.47)	3928	18.21(5.50)	3827	17.84(5.43)
Child Outcome variables (S4 – 7 years)						
emotional problems SDQ [a]	5,701	1.32(1.58)	2899	1.28(1.61)	2802	1.36(1.54)

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conduct problems SDQ [a]	5,705	1.13(1.34)	2900	1.28 (1.44)	2805	0.97(1.22)
hyperactivity SDQ [a]	5,698	3.01(2.39)	2898	3.43(2.47)	2800	2.57 (2.20)
peer problems SDQ [b]	5,697	0.98(1.41)	2895	1.05(1.51)	2802	0.89(1.30)
prosocial SDQ [a]	5,705	8.68(1.54)	2901	8.43(1.66)	2804	8.95(1.36)
Child emotion-regulation	5,706	4.87(0.67)	2901	4.78(0.70)	2805	4.97(0.61)

[a] Higher scores indicate more severity of symptoms

[b] Higher scores indicate less severity of symptoms

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Table 2 Intercorrelations for predictor, mediator and outcomes used in model

Variables	Paternal depressive symptoms (S1-9 months)	Father-child conflict (S2 – 3 years)
Paternal depressive symptoms (S1 - 9 months)		
Father-child conflict(S2)	0.24*	
	N=7,755	
Child emotional problems SDQ(S4)	0.07	0.10*
	N=6,827	N= 5,701
Child conduct problems SDQ(S4)	0.10*	0.18*
	N=6,832	N=5,705
Child hyperactivity SDQ(S4)	0.08*	0.17*
	N=6,824	N=5,698
Child peer problems SDQ(S4)	0.08*	0.10*
	N=6,819	N=5,697
Child prosocial SDQ(S4)	-0.04*	-0.10*
	N=6,833	N=5,705
Child emotion-regulation(S4)	-0.10*	-0.20*
	N=6,837	N=5,706

$p<0.001$=*

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Table 3: Descriptive statistics of variables that predict drop-out

Predictor of drop out (S1)	Sample at 9-months (S1 – 9 months)		Sample at 3 years (S2 – 3 years)			Sample at 7 years (S4 – 7 years)		
	Initial sample		Remained in sample		Dropped out	Remained in sample		Dropped out
	n		n		n	n		n
Paternal depressive symptoms	12,396		9,604		2,792	6,933		2,671
Rutter scale scores: Mean (SD)		1.35		1.30	1.50		1.26	1.41
		(1.53)		(1.50)	(1.69)		(1.47)	(1.58)
Socio-economic factors								
Fathers' education (%)	12,386		9,598		2,788	6,930		2,668
None		19		16	28		14	22
School level or higher		81		84	73		86	78
Fathers household poverty indicator (%)	12,364		9,587		2,777	6,922		2,665
Above 60% median		78		81	65		85	72
Below 60% median		22		19	35		15	28

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Table 4 Adjusted mediation models showing the effect of paternal depressive symptoms at 9 months on children's behavioural and emotional development at 7 years via father-child conflict at 3 years old

Model	Model 1 [a]		Model 2 [b]				Model 3 [c]			
Outcome	All children Paternal depressive symptoms mediated via father-conflict		Boys		Girls		All children Paternal depressive symptoms mediated via father-conflict, and accounting for child gender interaction effects		Gender x paternal depressive symptoms		Gender x father-child conflict	
	Coef [d] **(95% CI)**	P	**Coef** [d] **(95% CI)**	P	**Coef** [d] **(95% CI)**	P	**Coef** [d] **(95% CI)**	P	**Coef** [d] **(95% CI)**	P	**Coef** [d] **(95% CI)**	P
SDQ												
Emotional problems												
Direct	-0.00 (-0.04 - 0.04)	0.988										
Indirect	0.03 (0.02 - 0.04)	<0.001										

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	Total	0.03 (-0.01 - 0.07)	0.182									
Conduct problems												
	Direct	0.00 (-0.04 - 0.04)	0.952	0.02 (-0.04 - 0.08)	0.473	-0.02 (-0.06 - 0.02)	0.354	0.03 (-0.03 - 0.08)	0.366	-0.05 (-0.12- 0.02)	0.192	0.00 (-0.01 - 0.02)	0.803
	Indirect	0.03 (0.02 - 0.04)	<0.001	0.04 (0.02- 0.05)	<0.001	0.03 (0.02 - 0.04)	<0.001	0.04 (0.02- 0.05)	<0.001	-0.04 (0.05 - -0.02)	<0.001	0.04 (0.03 - 0.05)	<0.001
	Total	0.04 (0.00- 0.07)	0.041	0.06 (0.00 - 0.11)	0.043	0.01 (-0.03- 0.05)	0.640	0.06 (0.01 - 0.12)	0.020	-0.09 (-0.16 - -0.02)	0.017	0.04 (0.03 - 0.05)	<0.001
Hyperactivity/ inattention													
	Direct	-0.00 (-0.04 - 0.04)	0.968										
	Indirect	0.05 (0.03 - 0.06)	<0.001										
	Total	0.05 (-0.01 - 0.11)	0.125										
Peer problems													
	Direct	0.00 (-0.04 - 0.05)	0.866										
	Indirect	0.02	<0.001										

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		(0.01 - 0.02)										
	Total	0.02	0.352									
		(-0.02 - 0.06)										
Prosocial												
	Direct	0.04	0.071									
		(-0.00 - 0.08)										
	Indirect	-0.02	<0.001									
		(-0.02 - -0.01)										
	Total	0.02	0.289									
		(-0.02- 0.06)										
Emotion regulation												
	Direct	-0.01	0.680	-0.00	0.862	-0.00	0.882	-0.01	0.567	0.01	0.653	0.01	0.160
		(-0.04 - 0.03)		(-0.03 - 0.02)		(-0.03 - 0.02)		(-0.03 - 0.02)		(-0.03 - 0.04)		(-0.00 - 0.01)	
	Indirect	-0.02	<0.001	-0.02	<0.001	-0.01	<0.001	-0.02	<0.001	0.02	<0.001	-0.02	<0.001
		(-0.02- -0.01)		(-0.03 - -0.01)		(-0.02 - -0.01)		(-0.03- -0.01)		(0.01 - 0.03)		(-0.03 - -0.02)	
	Total	-0.02	0.010	-0.02	0.063	-0.01	0.216	-0.03	0.011	0.03	0.062	-0.02	<0.001
		(-0.03 - -0.00)		(-0.05 - 0.00)		(-0.04 - 0.01)		(-0.05 - -0.01)		(-0.00 - 0.06)		(-0.02 - -0.01)	
	Equation-level goodness of fit	0.32		0.17		0.15		0.57					

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R^2			
Model fit: Standardized Root Mean Square Residual (SRMR)	0.114	0.068	0.052

[a] Sample size was 3,514
[b] Sample size was 3,520(sample size went up because from model 1 and 2, non-significant variables were not taken forward. As stata run's complete case analysis, the dropping of variables emotional problems, hyperactivity, peer problems and prosocial increased the sample size because maybe these variables had incomplete/missing data.
[c] Sample size was 3,520
[d] All coefficients were standardized

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Table 5 Adjusted mediation models showing the effect of paternal depressive symptoms at 9 months on children's behavioural and emotional development at 7 years via father-child conflict at 3 years old after controlling for maternal depressive symptoms, child temperament, SES (9 months) and marital conflict at all time-points.

Model			Model 4 [a]			
Outcome	All children Paternal depressive symptoms mediated via father-conflict, and accounting for child gender interaction effects (adjusting for marital conflict at all time-points)		Gender x paternal depressive symptoms		Gender x father-child conflict	
	Coef [b] **(95% CI)**	P	**Coef** [b] **(95% CI)**	P	**Coef** [b] **(95% CI)**	P
SDQ						
Conduct problems						
Direct	0.01 (-0.04 - 0.08)	0.647	-0.03 (-0.11- 0.02)	0.343	-0.00 (-0.02 - 0.01)	0.932
Indirect	0.03 (0.02- 0.05)	<0.001	-0.04 (0.05 - -0.02)	<0.001	0.04 (0.02 - 0.05)	<0.001
Total	0.05 (-0.01 - 0.11)	0.098	-0.08 (-0.14 - 0.00)	0.057	0.04 (0.03 - 0.05)	<0.001

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Emotion regulation						
Direct	-0.01 (-0.03 - 0.02)	0.615	0.01 (-0.03 - 0.04)	0.760	0.01 (-0.00 - 0.02)	0.150
Indirect	-0.02 (-0.03- -0.01)	<0.001	0.02 (0.01 - 0.03)	<0.001	-0.02 (-0.03 - -0.02)	<0.001
Total	-0.03 (-0.05 - -0.01)	0.040	0.02 (-0.01 - 0.06)	0.160	-0.01 (-0.02 - -0.01)	<0.001
Equation-level goodness of fit R^2	0.59 (59%)					
Model fit: Standardized Root Mean Square Residual (SRMR)	0.043					

[a] Sample size was 3,147

[b] All coefficients were standardized

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Online Supplementary Tables

Online supplementary Table 1 Associations between covariates, paternal depressive symptoms (predictor) and father-child conflict (mediator)

Covariates (sweep 1)	Paternal depressive symptoms [a]		Father-child conflict [b]	
	Coef [d] (95% CI)	P	**Coef [d] (95% CI)**	P
Socio-economic factors				
Fathers' education		<0.001		0.435
None	Reference			
School level or higher	-0.44 (-0.53- -0.35)		-0.18 (-0.63-0.27)	
Fathers' household poverty indicator		<0.001		<0.001
Above 60% median	Reference			
Below 60% median	0.46 (0.36 0.55)		0.52 (0.13-0.31)	
Family factors				
Maternal depressive symptoms	0.17 (0.15-0.19)	<0.001	0.31 (0.22-0.40)	<0.001
Marital conflict	0.07 (0.06-0.08)	<0.001	0.15 (0.12-0.18)	<0.001
Child temperament	-0.02 (-0.02- -0.01)	<0.001	-0.07 (-0.10- -0.04)	<0.001
Child gender		0.133		<0.001
Boy	Reference			
Girl	-0.04 (-0.10 – 0.01)		-0.35 (-0.63- -0.08)	

[a] Sample size ranged from 7,650-12,396
[b] Sample size ranged from 4,873-7,755

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Online supplementary Table 2 Associations between covariates and child outcome variables

Covariates (Sweep 1)	Emotional [a]		Conduct [b]		Hyperactivity [c]		Peer problems [d]		Prosocial [e]		Emotion regulation [f]	
	Coef [d] (95% CI)	P	**Coef [d] (95% CI)**	P	**Coef [d] (95% CI)**	P	**Coef [d] (95% CI)**	P	**Coef [d] (95% CI)**	P	**Coef [d] (95% CI)**	P
Socio-economic factors												
Fathers' education		<0.001		<0.001		<0.001		<0.001		0.006		<0.001
None	Reference											
School level or higher	-0.37 (-.58- 0.17)		-0.45 (-0.61- -0.28)		-0.58 (-0.82- -.32)		-0.51 (-0.68 - -0.34)		0.20 (0.06-0.34)		0.19 (0.13-0.26)	
Fathers' household poverty indicator		0.011		<0.001		<0.001		<0.001		0.278		<0.001
Above 60% median	Reference											
Below 60% median	0.20 (0.05-0.35)		0.40 (0.26-0.55)		0.53 (0.29-0.78)		0.40 (0.25-0.56)		-0.07 (-0.19- 0.05)		-0,17 (-0.22- -0.12	
Family factors												
Maternal depressive symptoms	0.18 (0.15-0.22)	<0.001	0.17 (0.15-0.20)	<0.001	0.25 (0.20-0.29)	<0.001	0.14 (0.11-0.17)	<0.001	-0.09 (-0.11- -0.06)	<0.001	-0.08 (-0.9- -0.07)	<0.001

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Marital conflict	0.04	<0.001	0.05	<0.001	0.09	<0.001	0.05	<0.001	-0.05	<0.001	-0.03	<0.001
	(0.03-0.05)		(0.04-0.06)		(0.07-0.11)		(0.04-0.06)		(0.7- -0.04)		(-0.03-0.02)	
Child temperament	-0.03	<0.001	-0.02	<0.001	-0.03	<0.001	-0.01	0.001	0.04	<0.001	0.02	<0.001
	(-0.05- -0.02)		(-0.03 - -0.01)		(-0.05- -0.02)		(-0.02- -0.01)		(0.03-0.05)		(0.01-0.02)	
Child gender		0.099		<0.001		<0.001		<0.001		<0.001		<0.001
Boy	Reference											
Girl	0.08		-0.31		-0.86		-0.16		0.52		0.19	
	(-0.02-0.17)		(-0.38- -0.24)		(-1.01- -0.70)		(-0.23- -0.08)		(0.45-0.60)		(0.15-0.22)	

[a] Sample size ranged from 4,313-6,827

[b] Sample size ranged from 4,313-6,832

[c] Sample size ranged from 4,309-6,824

[d] Sample size ranged from 4,306-6,819

[e] Sample size ranged from 4,312-6,833

[f] Sample size ranged from 4,315-6,837

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Online supplementary Table 3 Adjusted mediation models (model 1) of the first five imputed datasets showing the effect of paternal depressive symptoms at 9 months on children's behavioural and emotional development at 7 years via father-child conflict at 3 years old (M=dataset number).[a]

Imputed dataset (M)[b]	M1		M2		M3		M4		M5	
	Coef [d] (95% CI)	P	**Coef [d] (95% CI)**	P	**Coef [d] (95% CI)**	P	**Coef [d] (95% CI)**	P	**Coef [d] (95% CI)**	P
SDQ										
Emotional problems										
Direct	0.00 (-0.00 - 0.04)	0.085	-0.01 (-0.02 - 0.01)	0.504	-0.01 (-0.02 - 0.01)	0.519	0.01 (-0.01 - 0.03)	0.354	-0.00 (-0.02 - 0.02)	0.958
Indirect	0.02 (0.01 - 0.02)	<0.001	0.02 (0.02 - 0.03)	<0.001	0.02 (0.01 - 0.02)	<0.001	0.02 (0.01 - 0.02)	<0.001	0.02 (0.02 - 0.02)	<0.001
Total	0.03 (0.02 - 0.05)	<0.001	0.02 (-0.00 - 0.03)	0.084	0.02 (-0.02 - 0.03)	0.190	0.03 (0.01 - 0.05)	0.003	0.02 (0.00 - 0.04)	0.037
Conduct problems										
Direct	0.02 (0.00 - 0.03)	0.038	0.01 (-0.00- 0.03)	0.098	0.00 (-0.01 - 0.02)	0.541	0.01 (-0.01- 0.02)	0.477	0.01 (-0.01 - 0.02)	0.385
Indirect	0.03 (0.02 - 0.03)	<0.001	0.03 (0.03- 0.03)	<0.001	0.03 (0.03 - 0.03)	<0.001	0.03 (0.03 - 0.03)	<0.001	0.03 (0.03 - 0.04)	<0.001
Total	0.04 (0.03- 0.06)	<0.001	0.04 (0.03 - 0.06)	<0.001	0.03 (0.02- 0.05)	<0.001	0.04 (0.02 - 0.05)	<0.001	0.04 (0.02 - 0.06)	<0.001
Hyperactivity/inattention										
Direct	0.01 (-0.02 - 0.03)	0.655	0.01 (-0.02 - 0.03)	0.651	-0.02 (-0.04 - 0.01)	0.246	0.00 (-0.02 - 0.03)	0.763	-0.00 (-0.03 - 0.02)	0.831
Indirect	0.01 (0.00 - 0.01)	<0.001	0.05 (0.04 - 0.06)	<0.001	0.05 (0.04 - 0.05)	<0.001	0.05 (0.04 - 0.06)	<0.001	0.05 (0.05 - 0.06)	<0.001
Total	0.06(0.03 - 0.08)	<0.001	0.06 (0.03- 0.08)	<0.001	0.03 (0.00 - 0.06)	0.026	0.05 (0.03 - 0.08)	<0.001	0.05 (0.02 - 0.08)	<0.001

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Peer problems										
Direct	0.02 (0.01 - 0.04)	0.007	0.01 (-0.01 - 0.02)	0.540	-0.01 (-0.01 - 0.03)	0.219	0.02 (0.01 - 0.04)	0.023	0.02 (-0.00 - 0.03)	0.069
Indirect	0.02 (0.01 - 0.02)	<0.001	0.02 (0.01 - 0.02)	<0.001	0.02 (0.02 - 0.02)	<0.001	0.01 (0.01 - 0.02)	<0.001	0.02 (0.01 - 0.02)	<0.001
Total	0.04 (0.02 - 0.05)	<0.001	0.02 (0.01 - 0.04)	0.003	0.03 (0.01 - 0.05)	<0.001	0.03 (0.02 - 0.05)	<0.001	0.03 (0.02 - 0.05)	<0.001
Prosocial										
Direct	0.03 (0.01 - 0.04)	0.006	-0.01 (-0.01 - 0.02)	0.491	0.02 (0.01 - 0.04)	0.007	0.01 (-0.01 - 0.03)	0.163	0.03 (0.01 - 0.05)	0.003
Indirect	-0.02 (-0.02 - -0.01)	<0.001	-0.02 (-0.02 - 0.01)	<0.001	-0.02 (-0.02 - -0.01)	<0.001	-0.01 (-0.02 - -0.01)	<0.001	-0.02 (-0.02 - -0.01)	<0.001
Total	0.01 (-0.01- 0.03)	0.350	-0.01 (-0.03 - 0.01)	0.251	0.01 (-0.01 - 0.03)	0.301	-0.00 (-0.02- 0.02)	0.848	0.03 (-0.01 - 0.03)	0.219
Emotion regulation										
Direct	-0.01 (-0.01 - 0.00)	0.134	-0.00 (-0.01 - 0.01)	0.873	-0.00 (-0.01 - 0.01)	0.686	-0.01 (-0.01- 0.00)	0.389	-0.00 (-0.01 - 0.00)	0.231
Indirect	-0.02 (-0.02- -0.01)	<0.001	-0.02 (-0.02 - -0.01)	<0.001	-0.02 (-0.02 - -0.01)	<0.001	-0.02 (-0.02 - -0.01)	<0.001	-0.02 (-0.02 - -0.01)	<0.001
Total	-0.02 (-0.03 - -0.00)	<0.001	-0.02(-0.03 - -0.01)	<0.001	-0.02 (-0.02 - -0.01)	<0.001	-0.02 (-0.03 - -0.01)	<0.001	-0.02 (-0.03 - -0.01)	<0.001

[a] Please note: that in Stata command for conducting analysis on pooled imputed datasets (mi estimate) does not support SEM analysis (stata multiple-imputation reference manual release 13), therefore analysis was conducted on the first 5 datasets to indicate results from the imputed data.

[b] Sample size was 12,396 for all datasets. All predictor and outcome variables were used as predictors in the imputation model (set for 25 imputations)

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